The K-Group Network Interdiction Problem

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Purpose of This Talk

- Describe a new network interdiction problem—a generalization of the max-flow network interdiction problem
- Describe the min-max model for the problem and conversion to a MIP
- Describe an easier-to-solve approximating IP
- Give computational results

Problem definition

- **A network user (adversary) has *K* force groups deployed across a large area**
- **He wishes move the right amount of the right materiel between these force groups over, say, a road network**
- **We, the interdictor, wish to minimize the amount of materiel that can be moved by interdicting arcs in the network…using limited interdiction resources.**

Our model, in words

- A network user (adversary) has *K* force groups deployed across a large area
- He wishes maximize the flow of a generic commodity among the force groups across a capacitated network
- We, the interdictor, wish to minimize this maximum flow using limited interdiction resources

MCNIM, multi-commodity network interdiction model

- Given undirected network G=(N,A), and resource r_{ij} needed to interdict arc (i,j)
- Arc capacities u_{ij} and total resource R
- K force groups represented by subsets of nodes
- Minimize sum of flows that can leave all groups simultaneously
- Treat each group of nodes as a source while all other groups are sinks

Related work

- **Max-flow network interdiction model**
- **Deterministic: Wollmer (1964, 1970), Durbin (1966), McMasters and Mustin (1970), Helmbold (1971), Ghare, Montgomery, and Turner (1971), Lubore, et al. (1971, 1975), Steinrauf (1991), Wood (1993), Cormican (1995)**
- **Stochastic: Cormican (1995), Cormican, Morton and Wood (1995)**

MPNIM, multi-partition approximating model

- Given same setup, interdict arcs, and define a partition of nodes (each group in one subset) so that total uninterdicted capacity between partition subsets is minimized
- Flow not explicitly modeled
- Provides an upper bound on MCNIM (exact if $K = 2$)
- Easier to solve

Related work

- **The multi-way cut problem, studied mostly by CS combinatorialists**
- ***K* is usually large, not 3 or 4 or 5**
- **Our formulation appears to be new**

Comments and Conclusions

- **The models work**
- **MPNIM is easier to solve and provides good approximations to MCNIM**
- **A new formulation for the multi-way cut problem has been devised**